OxfordCryosystems

OXFORD CRYOSYSTEMS

Coolstar Cryopump 400, 800, 1500 and 3500

Operation & Instruction Guide

COOLSTAR CRYOPUMPS

Operation & Instruction Guide 1.2

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1 Introduction 2
1.1 Scope and Definitions 2
1.2 General Description 3
1.3 Coldhead 3
1.4 Controlling Refrigeration Power 4
2 Technical Data 6
2.1 Performance 6
2.2 Mechanical data 7
3 Installation 9
3.1 Safety 9
3.2 Unpacking and inspection 10
3.3 Connect the cryopump to the system vacuum chamber 10
3.4 Connecting the helium lines 11
3.5 Connecting the coldhead motor supply 12
4 Operation 13
4.1 Start-up procedure 13
4.2 Normal operation 14
4.3 Shut Down 14
5 Maintenance 15
5.1 Safety 15
5.2 Adding helium gas 16
5.3 Decontaminating the helium gas circuit 16
5.4 Cleaning the Coolstar cryopump 18
5.5 Coldhead maintenance 21
5.6 Fault finding 21
6 Storage and disposal 24
6.1 Storage 24
6.2 Disposal 24
7 Service, spares and accessories 25
7.1 Introduction 25
7.2 Service 25
7.3 Spares 25
7.4 Accessories 26
8 Equipment return procedure 28
8.1 Introduction 28
8.2 Guidelines 28
8.3 Returns procedure 28

Figures

Figure 1 - Warning symbols 2
Figure 2 - External view of Coolstar 400 and 800 cryopumps 3
Figure 3 - External view of Coolstar 1500 and 3500 cryopumps 4
Figure 4 - Cutaway view of a Coolstar cryopump 5
Figure 5 - Purging the cryopump coldhead 17

Tables

Table 1 - Performance data ... 6
Table 2 - Overall dimensions (mm) of Coolstar 400 / 800 cryopumps ... 7
Table 3 - Overall dimensions (mm) of Coolstar 1500 / 3500 cryopumps ... 7
Table 4 - Inlet flange options ... 8
Table 5 - Cryopump cool down times ... 13

1 Introduction

1.1 Scope and Definitions

This manual provides installation operation and maintenance instructions for the Coolstar cryopumps 400, 800, 1500 and 3500. You must use your pump as specified in this manual. Read this manual before you install and operate your version of the pump.

Important safety information is highlighted as WARNING and CAUTION instructions; you must obey these instructions. The use of WARNINGS and CAUTIONS is defined below.

Warning

Warnings are given where failure to observe the instruction could result in injury or death to person.

Caution

Caution is given where failure to observe the instruction could result in damage to the equipment, associates equipment and process.

The units used throughout this manual conform to the SI international system of units of measurement.

The following warning symbols are on the pump:

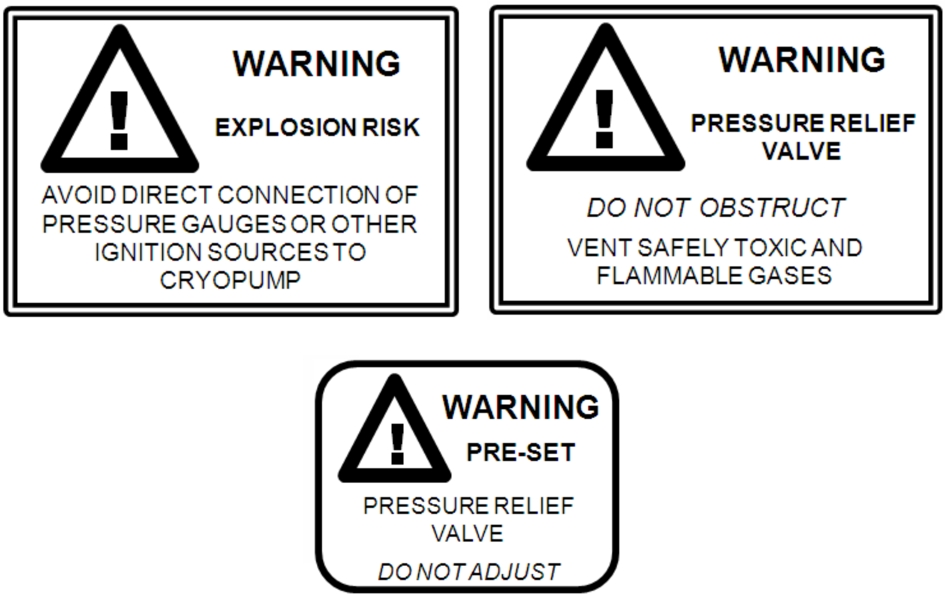

Figure 1 - Warning symbols

1.2 General Description

The Coolstar cryopump consists of a coldhead (see section 1.3), its associated pumping arrays or Cryopanels and the surrounding vacuum shroud (see section 1.4). The coldhead assembly comprises the cryopump base flange and the coldhead itself. This assembly is attached to the vacuum shroud by means of a 'V' band clamp. Inside the vacuum shroud, and securely fixed to the coldhead first stage heat station, is the first stage Cryopanel, the open end of which carries the inlet louvre. Inside the first stage Cryopanel and inlet louvre is the second stage Cryopanel which is securely fixed to the second stage heat station on the cold head. The coldhead provides low temperature cooling of both first and second stage Cryopanel pumping arrays. These function to remove gases and vapours present in the vacuum system by two methods, cryo-condensation and cryo-adsorption.

1.3 Coldhead

With reference to Figure 2 and Figure 3, the coldhead is a two-stage cylinder/displacer assembly with a valve/motor assembly connected to the base of the cylinder.

The motor is a variable speed stepper drive-motor. Together with the coldhead rotary valve, the motor controls the flow of helium (from your compressor or Cryodrive) in the coldhead. One rotation of the drive-motor provides two complete cycles of the displacer.

The self-seal connectors allow the helium to flow into and out of the coldhead. At the inlet, the high pressure helium is at ambient temperature. The helium flows into the expansion chambers in the displacer, where it expands and cools. The low pressure helium flows through the internal heat exchanger to produce the cooling power to the heat-stations.

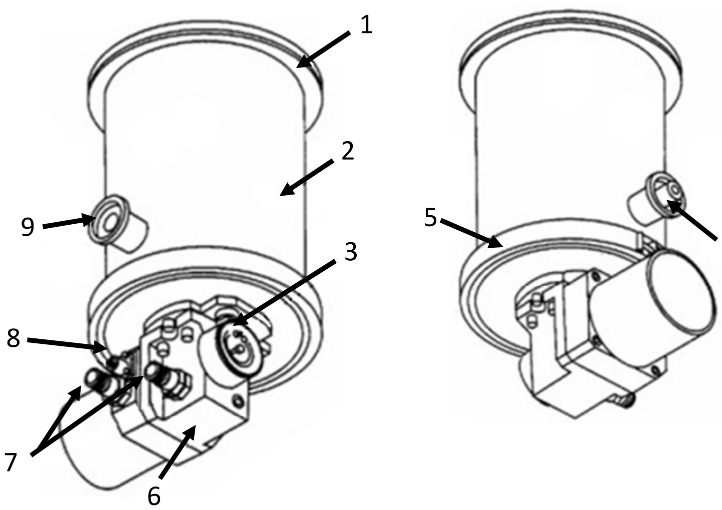

Figure 2 - External view of Coolstar 400 and 800 cryopumps

1. Inlet flange
2. Vacuum shroud
3. Location of hydrogen vapour pressure thermometer or silicon diode feed-through
4. Pressure relief valve (NW25 flange)
5. 'V' band clamp
6. Coldhead valve motor assembly
7. Helium gas inlet and outlet connectors
8. Cryopump cable connector
9. Roughing port (NW40 flange)

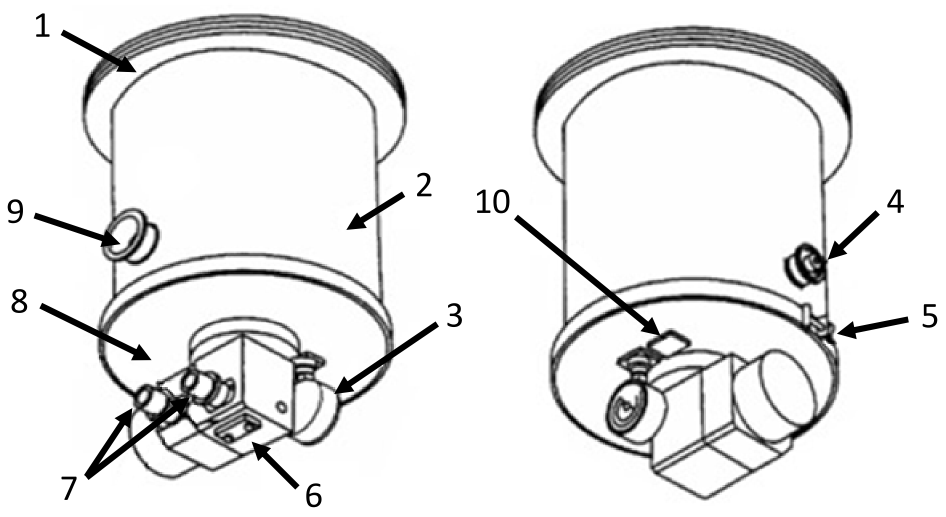

Figure 3 - External view of Coolstar 1500 and 3500 cryopumps

1. Inlet flange
2. Vacuum shroud
3. Location of hydrogen vapour pressure thermometer or silicon diode feed-through
4. Pressure relief valve (NW25 flange)
5. 'V' band clamp
6. Coldhead valve motor assembly
7. Helium gas inlet and outlet connectors
8. Cryopump cable connector
9. Roughing port (NW40 flange)
10. Purge accessory port blanking plate

1.4 Controlling Refrigeration Power

With reference to Figure 4, the inlet-louvre and the first stage Cryopanels (cooled to typically 80K) provide high speed pumping of the water and hydrocarbon vapours in the vacuum system.

The external surfaces of the second-stage Cryopanels (cooled to typically 15K) pumps gases such as nitrogen, oxygen and argon. The internal surfaces (which are coated with a layer of absorbent charcoal) pump gases such as hydrogen, helium and neon.

As the frozen gases and vapours build up on the surfaces of the Cryopanels, the temperature of the panels rises and the cryopump becomes less efficient. At some point, you will have to isolate the cryopump from the vacuum system using the high vacuum isolation valve and allow the pump to warm up to regenerate its pumping performance. To monitor the performance of the pump, a temperature sensor, either a hydrogen vapour pressure thermometer or a silicon diode thermometer, monitors the temperature of the second-stage Cryopanels.

The vacuum-shroud has a roughing port; connect your roughing pump to this port to reduce the internal gas pressure within the pump to a level which creates an insulating vacuum within the pump. The shroud also has an integral pressure-relief valve to release vapourising gases evolved during pump regeneration.

The pressure in the vacuum chamber, when the high-vacuum isolation valve is opened, is designated the crossover pressure and is defined as the pressure in the vacuum system at which the crossover from rough pumping to high-vacuum pumping takes place. The impulsive thermal load on the cryopump at the Maximum permissible Crossover Pressure (MCP) will result in a transient increase in second-stage Cryopanel temperature to a 20K maximum, thereby retaining previously pumped gases.

A sensor-port is provided on the base flange for mounting the vapour pressure thermometer or silicon diode temperature-sensor feed-through.

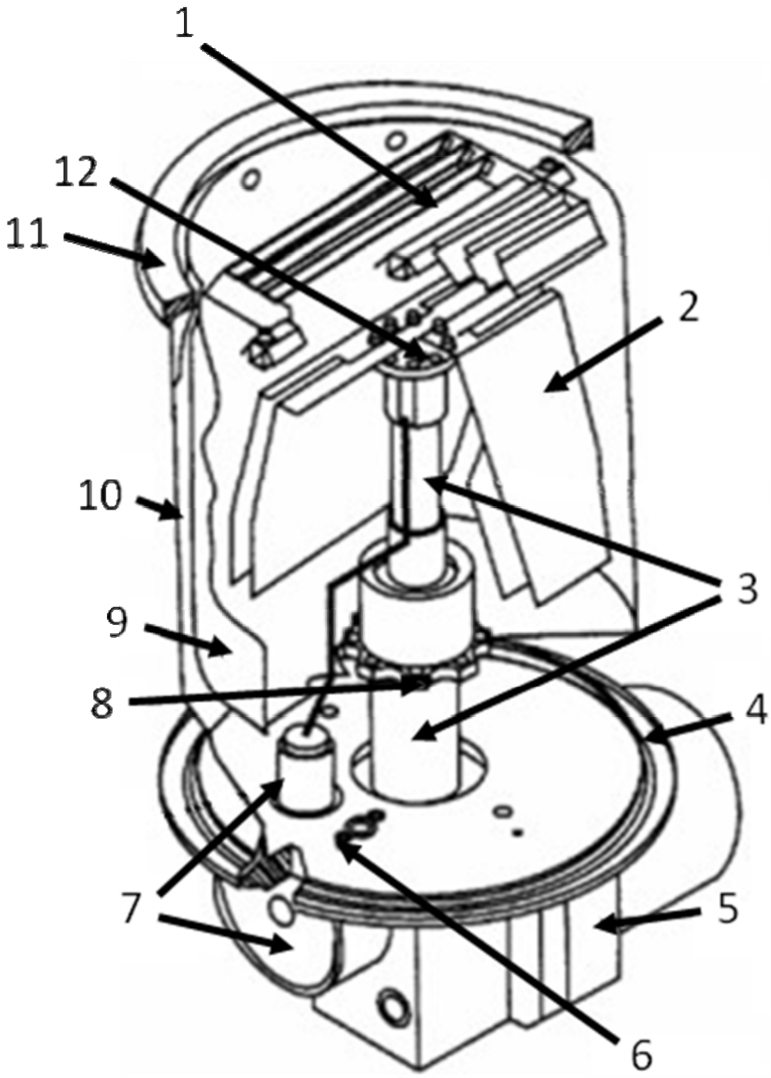

Figure 4 - Cutaway view of a Coolstar cryopump

1. Inlet-louvre
2. Second-stage Cryopanel
3. Coldhead displacer/cylinder assembly
4. Coldhead base-flange
5. Coldhead valve/motor assembly
6. Purge accessory port
7. Hydrogen vapour pressure thermometer
8. First-stage heat-station
9. First-stage Cryopanel
10. Vacuum-shroud
11. Inlet-flange
12. Second-stage heat-station

2 Technical Data

2.1 Performance

	400	**800**	**1500**	**3500**
Pumping speed (ls^{-1})				
Water vapour (H_2O)	1210	2915	4500	9500
Nitrogen (N_2)	350	800	1500	3500
Hydrogen (H_2)	495	1155	2500	4500
Argon (Ar)	275	640	1200	2800
Helium (He)	270	700	1000	1800
Throughput of argon (mbar ls^{-1} at 20K)				
Normal speed (50 Hz)	6.0	5.0	17.0	13.0
Normal speed (60 Hz)	7.0	6.0	19.0	15.0
Boost speed	7.5	6.5	20.0	16.0
Standby speed	4.5	3.0	11.5	6.5
Capacity (standard litres at 1 x 10^{-5} mbar)				
Hydrogen	3	5	14	30
Argon	190	400	1000	2000
Helium	0.03	0.05	0.1	0.2
Maximum crossover (mbar 1 at 20K)	75	120	290	500
Cool down time to 20K (min)	33	50	50	85

Table 1 - Performance data

2.2 Mechanical data

2.2.1 Overall dimensions

Cryopump Dimension	400		800	
	ISO100	CF6	ISO160	CF8
A	130	152	180	203
B	105	105	156	156
C	85	85	110.5	110.5
D	182	182	182	182
E	324	324	324	324
F	228	228	228	228
G	12	19.9	12	22.3
H	126.5	126.5	126.5	126.5
J	46	46	46	46
K	59	59	59	59
L	76	76	76	76
M	24	24	24	24
N	21	21	21	21
P	-	16	-	20
R	-	8.3	-	181
S	-	130.2	-	181
T	NW25	NW25	NW25	NW25

Table 2 - Overall dimensions (mm) of Coolstar 400 / 800 cryopumps

Cryopump Dimension	1500			3500		
	ISO200	ASA6	CF10	ISO320	ASA10	CF14
A	240	279.4	254	370	496.5	356
B	205	205	205	299	299	299
C	135.5	135.5	135.5	183	183	183
D	242	242	242	242	242	242
E	413	413	413	413	413	413
F	290	290	290	290	290	290
G	13	15	24.6	17	15	28.4
H	144.5	144.5	144.5	144.5	144.5	144.5
J	69	69	69	69	69	69
K	86	86	86	86	86	86
L	93	93	93	93	93	93
M	38	38	38	38	38	38
N	32	32	32	32	32	32
P	-	8	24	-	12	30
R	-	241.3	231.8	-	362	325
S	-	241.3	231.8	-	362	325
T	NW40	NW40	NW40	NW40	NW40	NW40

Table 3 - Overall dimensions (mm) of Coolstar 1500 / 3500 cryopumps

Inlet flange options	400	800	1500	3500
ISO	ISO 100	ISO 160	ISO 200	ISO 320
ASA	-	-	ASA 6”	ASA 10”
CF	CF 6”	CF 8”	CF 10”	CF 14”
Pressure relief valve connection	NW25	NW25	NW25	NW25
Roughing port flange	NW25	NW25	NW40	NW40
Maximum mass (kg)	6	8	16	26

Table 4 - Inlet flange options

3 Installation

3.1 Safety

WARNING

Obey the safety instructions given below and take note of appropriate precautions. If you do not, you can cause injury to people and damage to equipment.

- A suitably trained and supervised technician must install the pump.
- Ensure that the installation technician is familiar with the safety procedures which relate to the products handled by the pumping system. Wear the appropriate safety-clothing when you come into contact with contaminated components.
- Vent and purge the vacuum system before you start any installation work.
- Check that all the required components are available and of the correct type before you start work.
- Disconnect the other components in the pumping system from the electrical supply so that they cannot be operated accidentally.
- Do not reuse 'O' rings and Co-seals.
- Do not install hot-filament type vacuum gauges on the cryopump side of the high-vacuum isolation valve. When pumping flammable gases, a gauge of this type in this position could be a source of ignition.
- Do not install electrical equipment directly under the cryopump body. Moisture condensed on the pump body during regeneration may drip directly onto the equipment causing a potential hazard.
- Leak-test the system after installation work is complete to prevent leakage of hazardous substances out of the system and leakage of air into the system.
- When pumping toxic, corrosive or flammable gases, connect a vent pipe to the relief-valve to vent the gases to a safe location.
- Ensure that the area around the relief-valve remains clear to provide unimpeded gas flow down the vent pipe.
- When pumping corrosive or solvent gases, ensure that the vent pipe runs in a downward direction from the relief-valve, so that liquids drain from the relief-valve area.

3.2 Unpacking and inspection

3.2.1 General information

WARNING
You must use suitable lifting equipment to move the Coolstar cryopump. It is too heavy to lift by hand.

Remove all packing materials and protective covers and check the Coolstar cryopump.

If the Coolstar pump is damaged, notify Oxford Cryosystems and the carrier in writing within three days; state the serial number of the Coolstar cryopump together with your order number and your supplier's invoice numbers. Retain all packing materials for inspection. Do not use the Coolstar cryopump.

If the Coolstar cryopump is not to be used immediately, replace the protective covers. Store the Coolstar cryopump in suitable conditions, as described in Section 6.

Note: You may find some carbon (black granules) adsorbent material from the second-stage Cryopanels loose within the pump. This is normal following transit handling and will not affect your cryopump performance.

If a HVP temperature gauge is fitted, check that the gauge indicates 60 ± 3 p.s.i.g. at standard temperature and pressure.

Remove the mounting flange protective cover and inspect the inlet-louvre, the mounting-flange and the flange sealing surfaces for damage. If the cryopump is not to be installed immediately then replace the protective cover.

3.2.2 Locating the cryopump

Provide a level platform for the cryopump. Locate the cryopump to provide access to all relevant parts for maintenance.

If you are intending to locate the cryopump inside an enclosure, make sure there is adequate ventilation around the cryopump so that the ambient temperature does not exceed +40°C.

3.3 Connect the cryopump to the system vacuum chamber

1. The cryopump may be installed in any orientation without affecting operation. Give consideration however, to the possible effects of the flow of cold liquid gases produced by the cryopump during regeneration.

2. Install a high-vacuum isolation valve between the pump and the system vacuum chamber to isolate the pump from the chamber during rough pumping cool down and regeneration.

3. Install the valve such that it can withstand the differential pressure in the cryopump which can occur during regeneration of the cryopump.

4. Install gate valves with the actuating mechanism on the cryopump side of the valve-plate.

5. Install butterfly valves at the narrowest side of the taper sealing bore facing away from the cryopump and fit a spacer between the pump and the valve to ensure the valve-plate has clearance to fully open.

6. Remove the protective cover from the pump mounting flange if an 'O' ring seal is fitted to the flange, check the seal is correctly fitted and lightly lubricate with vacuum grease.

7. To achieve the correct orientation for the system, orientate the cryopump until the NW25 roughing port for the 400/800, or the NW40 roughing port for the 1500/3500, and/or relief-valve port are correctly positioned, then insert and tighten the mounting flange bolts.

8. Fit the cryopump to the vacuum chamber, tightening fixings progressively and evenly.

3.4 Connecting the helium lines

1. Carefully slacken off the lower 'V'-band clamp (Figure 2 and Figure 3, item 5) and rotate the coldhead motor-housing (item 6) until the coldhead gas line supply and return connections are correctly orientated.

2. Retighten the lower flange 'V'-band clamp.

3. Remove dust plugs and caps from:

   - the interconnecting helium gas lines
   - the coldhead
   - the compressor gas supply and return connections.

Ensure that all the exposed sealing faces of these connections are free from debris that would affect the seal quality, and are lightly lubricated with vacuum grease.

4. Connect the helium gas hoses between the compressor and coldhead, in the following order:

   - Connect the GREEN helium return line to the gas RETURN connector at the rear of the compressor unit.
   - Conned the RED helium supply line to the gas SUPPLY connector at the rear of the compressor unit.
   - Connect the RED helium supply line to the RED gas supply connector at the coldhead.
   - Connect the GREEN helium return line to the GREEN gas return connector at the coldhead.

> **Note**
>
> Two spanners must be used for this operation to avoid damage to the coupling. Support the hose during the connection process to minimise the small amount of gas which may leak from the coupling whilst it is being connected; complete the procedure quickly to prevent gas leakage.

5. Open the Cryodrive front cover and check the pressure gauge reading. The static pressure of a typical cryopump installation at an ambient temperature between 16°C to 38°C and using the 3 metre interconnecting gas hoses should be 16.5 ± 1.0 bar (239 ± 14.5 p.s.i.g).

6. If the indicated pressure is below 15.5 bar (225 p.s.i.g.) but higher than 2 bar (29 p.s.i.g.), add helium gas.

Refer to the Cryodrive Operation & Installation Guide for further information or contact Oxford Cryosystems.

3.5 Connecting the coldhead motor supply

Connect the coldhead motor supply lead to the bayonet fitting on the rear of the coldhead motor-housing. Attach the cable screen earth to a suitable earth-stud.

4 Operation

4.1 Start-up procedure

WARNING

Extremely high pressure can be generated within the cryopump if the relief valve malfunctions or is blocked. Do not restrain, block or alter the valve in any way.

CAUTION

Close the roughing valve immediately after start-up of the cryopump. This will minimise oil back streaming into the pump which can permanently contaminate the second-stage carbon adsorbent. Use a molecular sieve trap in the evacuation line to prevent back diffusion taking place.

1. Close the pump isolation valve.
2. Rough the pump to 5×10^{-2} mbar.
3. Start the Cryodrive.
4. Check that the cryopump produces a light tapping noise. This indicates that the cryopump is operating. If you are unable to detect motion, ensure that the helium hoses and the coldhead electrical cable are correctly connected.
5. Close the roughing valve when the Cryodrive is switched on.
6. List the compressor unit and cryopump temperature readings at regular intervals during initial cool down. With the high-vacuum isolating valve closed, the cryopump should attain a second-stage temperature of 18K or less (green indication on the HVP thermometer or temperature status indicator) in accordance with Table 5.
7. If the cryopump does not attain operating temperature consistent with the values in Table 5, refer to the fault finding procedures detailed in Section 5.6.
8. When the cryopump attains a temperature of 20K or less it is ready for vacuum operation.

Cryopump	2nd stage temp.	Time after start up (approx)	
		Standard speed	Fast speed
Coolstar 400	20K	53 min	33 min
Coolstar 800	20K	76 min	50 min
Coolstar 1500	20K	75 min	50 min
Coolstar 3500	20K	150 min	85 min

Table 5 - Cryopump cool down times

4.2 Normal operation

The Coolstar high-vacuum cryopump is designed to operate unattended under normal operating conditions, with an occasional check of the compressor unit helium pressure gauge reading. The gauge should indicate a pressure of between 20 to 22 bar (290 to 319 p.s.i.g.). If the gauge reading varies above or below this range refer to the fault finding procedures detailed in the manual which supports your compressor.

For optimum performance, maintain the temperature of the cryopump second-stage below 20K. This is denoted by the green/orange ranges on the HVP thermometer or silicon-diode temperature status indicator.

4.3 Shut Down

CAUTION
Do not expose the cold, internal components of the cryopump to atmosphere immediately after shut-down. Always allow the pump to warm up to room temperature before exposure, this will minimise the quantity of water absorbed into the charcoal adsorbent of the second-stage Cryopanel.

Note: The cryopump may take as long as 4 hours to warm to ambient temperature dependent on the quantity of gas held by the Cryopanels. Accelerate warm-up if necessary by introducing a clean, dry, gas such as nitrogen or argon, through the purge tube accessory and/or heating the pump body with a heater band accessory, (see Section 7 for details of the EHV Accessory Range).

1. Close the high-vacuum isolation valve between the cryopump and vacuum system.

2. Switch the Cryodrive off.

5 Maintenance

5.1 Safety

WARNING

Obey the safety instructions given below and take note of appropriate precautions. If you do not, you can cause injury to people and damage to equipment.

- A suitably trained and supervised technician must install the pump.
- Ensure that the installation technician is familiar with the safety procedure which relate to the produce pumped. Wear the appropriate safety-clothing when you come into contact with contaminated components. Dismantle and clean contaminated components inside a fume-cupboard.
- Before you work on the cryopump, ensure that you disconnect and isolate the electrical supply to the installation by switching the supply circuit isolating switch to OFF. If possible, lock the switch in the OFF position and withdraw the circuit fuses.
- The helium charging hose must be rated for the maximum regulator delivery pressure. A hose not so rated could rupture, causing a hazard to personnel and damage to equipment.
- Do not use helium that is less than 99.995% pure (dew point –27°C) to avoid possible helium contamination.
- The coldhead must be warmed to room temperature before connecting the helium bottle to the charge and vent adaptor.
- If the cryopump has been used to pump toxic or otherwise dangerous gases, do not break the vacuum seal between the pump and the system.
- Do NOT disconnect the coldhead supply and return gas lines during or immediately after low-temperature operation unless for cold purging during decontamination procedures (see Section 5.3).
- Never attempt to dismantle the coldhead without venting its 16 bar helium charge to atmosphere.
- Ensure that when depressurising a coldhead the vented gas is safely directed away from personnel.
- Back-diffusion of oil vapour from a rouging pump can contaminate the coldhead. Use a molecular sieve trap in the evacuation line.
- Never dismantle the coldhead while it is still cold. Condensation wetting of the internal parts may cause malfunction or poor performance.
- Do not allow the gas line coupling halves to rotate during connection or disconnection or they may be damaged.

5.2 Adding helium gas

During normal operation you will be required to add helium gas only to counteract small losses caused by coupling and decoupling gas lines. If it becomes necessary to add helium frequently, check your installation for minor leaks. Leaks are generally caused by incorrectly tightened self-sealing couplings, debris on the coupling sealing faces or badly seated relief-valves.

Carry out charging with the compressor shut down. We recommend that you use the charge and vent adapter accessory (refer to Section 7.4.8).

5.3 Decontaminating the helium gas circuit

Contamination of the helium gas circuit of a Coolstar pump is indicated by sluggish or intermittent operation of the coldhead displacer piston resulting in poor ultimate temperatures. Severe cases of contamination may cause the displacer piston to seize. If contamination is suspected, carry out the following decontamination procedure to restore the pump's performance. The following purge procedure (see Section 5.3.2) is also used to purge a coldhead of contaminants following exposure to atmosphere during coldhead maintenance.

In cases of severe contamination, contact Oxford Cryosystems.

You will require a charge and vent adaptor refer to Section 7.4.8. For the following procedure refer to the charge and vent adaptor instructions to ensure familiarity with the product and its usage. The clean-up procedure is detailed in Section 5.3.1.

5.3.1 Clean-up of the coldhead

WARNING

High internal pressure can result during warm-up if a coldhead is disconnected from the gas liner when cold. When carrying out the procedure for coldhead de-contamination immediately vent the coldhead (using the charge and vent adaptor accessory) down to not less than 2 bar after disconnecting the gas lines.

Do not reduce the coldhead pressure below 2 bar (30 p.s.i.g). Reduction of pressure below this level could introduce additional contaminants into the coldhead.

Note: Contaminants in the helium gas circuit tend to freeze inside the coldhead during operation of the pump. The longer you operate the pump beyond the one-hour period the greater the volume of contaminants isolated in the coldhead and the more effective the de-contamination process will be.

1. Cool down the cryopump and operate for one to three hours.

2. Shut down the cryopump by first closing the high-vacuum valve (if fitted) and switching the compressor off.

3. Immediately after the cryopump is shut down, disconnect the helium supply and the return lines at the coldhead connectors (Figure 2 and Figure 3, item 7).

4. Immediately attach the charge and vent adaptor accessory to the high pressure (red) coldhead connection, ensuring that all three valves on the adaptor are closed.

5. Immediately following step 4, reduce the pressure in the coldhead to not less than 2 bar (30 p.s.i.g) using the charge and vent valve V1 to vent the coldhead.

6. Allow three hours for the coldhead to warm-up to room temperature. If required, shorten the warm-up time by back-filling the vacuum chamber served by the pump to one atmosphere with dry argon or nitrogen.

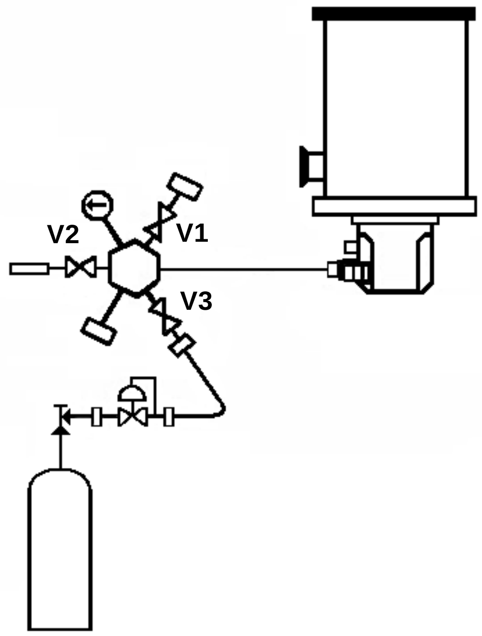

Figure 5 - Purging the cryopump coldhead

V1	Charge and vent valve
V2	Evacuation valve (If vacuum pump available)
V3	Charge line valve

5.3.2 Purging the helium system

CAUTION

Back diffusion of oil-vapour from a roughing-pump can contaminate the coldhead. You must use a molecular sieve trap in the evacuation line to prevent back diffusion taking place.

1. Ensure that a helium bottle and suitable regulator (to provide up to 17 bar (246 p.s.i.g.) pressure) are available. We recommend that the maximum supply pressure of the regulator used does not exceed 40 bar (580 p.s.i.g.).

2. Connect a charging line, with an end termination suitable for connecting the 7/16 UNF (20 T.P.I) male flare fitting on the charge and vent adaptor valve V3, to the regulator. Do not connect this line to the adaptor at this time. Set the pressure regulator to zero supply pressure and open the cylinder valve.

3. To purge the charge line of contaminants, set the regulator to 2 to 3 bar delivery pressure and whilst helium is flowing from the end of the charging line, connect this to the flare adaptor on the charge and vent adaptor (valve V3).

4. With the charging line valve V3 closed, open the regulator valve to give a pressure of 17 bar (246 p.s.i.g) in the charging line.

5. Ensure valves V2 and V1 are both closed.

6. Back fill the coldhead with helium through the charge and vent adaptor valve V3 to a static charge pressure of 16.5 ± 1.0 bar (242 ± 14.5 p.s.i.g.). Close valve V3.

7. Depressurise the coldhead to not less than 2 bar (30 p.s.i.g.) using valve V1 to vent the coldhead. If a vacuum pump is available evacuate the coldhead via V2 using the 16.0 mm push fitting on the charge and vent adaptor accessory, from 2 bar down to less than 1 mbar. Monitor the evacuation pressure during this process.

8. Flush the coldhead thoroughly by repeating steps 6 and 7 four more times.

9. Backfill the coldhead again at the completion of the fifth flush to a static charge pressure of 16.5 ± 1.0 bar (242 ± 14.5 p.s.i.g.) and run the coldhead drive motor for about 20 seconds by switching on the compressor.

Note: If a vacuum pump is not available to evacuate the coldhead then depressurise the coldhead and repeat steps 6 to 9 four more times. The flushing procedure (steps 6 and 7) will then have been carried out 25 times with 5 intermediate coldhead drive motor runs (step 9) at the completion of each fifth flush.

10. Check that the coldhead is pressurised to a static charge pressure of 16.5 ± 1.0 bar (242 ± 14.5 p.s.i.g.).

11. Shut off the regulator, disconnect the gas supply-line from the charge and vent adaptor. Remove the charge and vent adaptor.

12. Reconnect the helium supply and return lines to the supply and return connections at the coldhead. Ensure that the colour coding of each line and connection is correctly matched.

13. Return the installation into service as detailed in Section 3.

5.4 Cleaning the Coolstar cryopump

> WARNING
>
> Indium metal is toxic. Ensure adequate precautions are taken to avoid skin contact or ingestion. Ensure safe disposal of any used material.

The Coolstar cryopump is designed so that an internal build-up of dust and corrosion during normal operation will not cause damage or seriously degrade the performance of the pump. The special copper Cryopanels are also protected against corrosion by nickel plating. In consequence, cleaning of the Cryopanels and internal surfaces of the pump is seldom necessary. If you find it necessary to clean the vacuum-shroud and Cryopanels, carry out the following procedures.

Note: Ensure that a cryopump service kit (see Section 7) or an adequate supply of indium metal sheet (0.1 mm thick) is available before you start to clean the Coolstar cryopump.

5.4.1 Disassembling the Coolstar cryopump

1. Remove the cryopump from the vacuum system and stand it upright, inlet-flange uppermost, on a clean surface. Remove the 'V'-band clamp securing the pump vacuum-shroud to the cryopump base-flange. Remove the pump vacuum-shroud and the sealing 'O' ring.

2. Remove the six M4 nuts (with spring and plain washers) securing the inlet louvre to the first-stage Cryopanel and pillars (where fitted).

3. Carefully free the inlet-louvre from the mating surfaces (carefully break the indium metal joint at each location to free the louvre). The louvre can now be lifted away.

4. Remove the eight M4 cap screws (with spring and plain washers) retaining the four second-stage Cryopanels to the second-stage heat-station.

5. Break the indium gasket joint by lightly tapping one side of each of the Cryopanels and remove.

6. Remove the four M4 cap screws clamping the inlet-louvre support pillars (where fitted) to the first-stage Cryopanel and remove.

7. Remove the M4 cap head screws (with spring and plain washers) clamping the first-stage Cryopanel to the first stage heat-station.

8. Lightly tap one side of the first-stage Cryopanel to break the indium metal joint between this panel and the coldhead heat-station and carefully lift the Cryopanel away, guiding it over the vapour bulb capillary (if fitted).

5.4.2 Cleaning the cryopump (first-stage)

1. Disassemble the cryopump as detailed in Section 5.4.1.

2. Wash the inlet-louvre, louvre support pillars, first-stage Cryopanel pump body and interior in a hot soapy water or detergent solution. Rinse in clean hot water and finally air or oven dry at 60°C maximum.

3. If any stains remain, wash these items using a lint free cloth and isopropyl alcohol. Avoid alcohol contacting the black paint coating on the inside surface of the first-stage Cryopanel. This will soften the coating rendering it liable to damage. Finally air or oven-dry at 60°C maximum.

5.4.3 Cleaning the second-stage Cryopanel

1. Disassemble the cryopump as detailed in Section 5.4.1.

2. If the second-stage Cryopanel carbon adsorbent is contaminated with hydrocarbon oil or vapour, discard it and replace with new one as it cannot be cleaned.

3. If the Cryopanel carbon adsorbent is not contaminated, but the nickel-plated surfaces require cleaning use the procedure detailed in Section 5.4.2 for the other Cryopanel. You must not allow cleaning solution to contact the carbon adsorbent as it will permanently 'poison' the carbon, affecting cryopump pumping capacity and cleanliness.

5.4.4 Servicing the pressure relief-valve

1. Disassemble the cryopump as detailed in Section 5.4.1.

2. The pressure relief-valve is located in the cryopump vacuum-shroud. Press the relief-valve plunger down (from inside the pump) to expose the sealing 'O' ring and carefully remove the 'O' ring.

3. From inside the pump, carefully remove the retaining cir-clip and the relief-valve plunger complete with spring.

4. Clean all the components thoroughly, including the relief-valve housing, with hot soapy water followed by a clean water rinse and air dry. To ensure safe cryopump operation you must replace any of these components if they are corroded or show visible signs of damage. Replacement springs and seal are supplied with the cryopump service kit.

5. Lightly grease the relief-valve sealing 'O' ring with suitable vacuum grease, then re-assemble the relief-valve.

6. Check that the relief-valve plunger moves freely over its full length of travel.

5.4.5 Reassembling the Coolstar cryopump

CAUTION

Do not over tighten the louvre mount screws or you may damage the thin radiation shield.

Note: Indium gaskets, which ensure good thermal contact, should be in place between all meeting surfaces. You can use the original indium gaskets provided they are not badly damaged, however we recommend that all gaskets are replaced. If a cryopump service kit is not available then these gaskets can be cut from indium metal sheet (0.1 mm thick).

1. Ensure that the first-stage indium gasket is in position on the first-stage coldhead heat-station. Replace the first-stage Cryopanel aligning the single large hole cut in the base with the purge accessory port.

2. Fit the M4 cap screws (with spring and plain washers) to retain the Cryopanel leaving four out at this stage. These are used to accommodate the louvre support pillars. Torque the screws to 0.8 Nm maximum.

3. Place two cap screws (with spring and plain washers) through the mounting holes in the end of the louvre support pillars. Place one of the circular indium washers over the end of each screw and fix the pillars in position within the first-stage Cryopanel. Repeat this for the second pillar. Torque the screws to 0.8 Nm maximum.

4. Replace the indium gasket on the second-stage coldhead heat-station and mount the second-stage Cryopanel leaflets such that the louvre support pillars are located centrally between the two inner Cryopanel leaflets. Take the eight cap head screws (with spring and plain washers) and, starting with the inner pair, replace the second-stage Cryopanel leaflets. Torque the screws to 0.8 Nm maximum

5. The Coolstar 3500 is fitted with a third Cryopanel leaflet pair mounted on top of the second leaflet pair, the clamping screws being common to both. Ensure that, on assembly, you place a circular indium gasket between the two panels at each screw location to ensure good heat transfer to the coldhead heat-station.

6. Ensure that new indium gaskets are fitted as required to the louvre mounting surfaces on the top edge of the first stage Cryopanel and louvre support pillars. Replace the pump inlet-louvre and fasten in place using the M4 nuts (with spring and plain washers); tighten to a maximum torque of 0.3 Nm.

7. Place the vacuum-shroud sealing 'O' ring (lightly greased) into the sealing groove on the cryopump base flange ensuring that the sealing groove is free from debris.

8. Lower the vacuum-shroud over the Cryopanels ensuring it locates correctly on the base-flange.

9. Replace the 'V' band clamp and tighten with the NW40 or NW25 for 400/800 pumping port correctly aligned for your application.

The cryopump is now ready for installation.

5.5 Coldhead maintenance

Note: Please refer to the Oxford Cryosystems coldhead Manual for comprehensive servicing instructions.

5.6 Fault finding

5.6.1 General notes on fault finding

The main indications of a fault in a high vacuum cryopump system are a rise in the base pressure of the vacuum chamber served by the pumping system or an unexpectedly high cryopump second-stage temperature. A rise in the vacuum chamber base pressure can be caused by either a leak in the vacuum chamber or a fault in the cryopumping system. High second-stage temperatures can be caused by high radiant loading, poor vacuum or a malfunction of the cryopumping system.

1. To check for a leak in the vacuum chamber, isolate the cryopump by closing the high-vacuum valve and leak test the vacuum chamber.

2. If there is no evidence of a leakage from the vacuum chamber, leak test the pump-side of the high-vacuum valve. This can be done using a helium leak detector with the cryopump shut down and warmed to room temperature. Helium leak checking with the cryopump operational requires a reduction of the coldhead speed to raise second-stage temperature to a level where helium is no longer pumped.

3. Keep an operating log to provide early indication of a possible fault. Such a log can also be useful in the diagnosis of faults.

5.6.2 Good vacuum performance but cryopump temperature abnormally high for system pressure

High radiant load to cryopump from system: close high vacuum valve and monitor pump for recovery. Fit baffle between cryopump and system.

For HVP thermometer cryopumps, a faulty thermometer can indicate an erroneously high cryopump temperature. Switch off the cryopump and monitor the thermometer needle for smooth movement. At 24K indicated, switch on the cryopump and again monitor cool down. Any erratic movement may indicate a faulty unit which should be replaced. Contact Oxford Cryosystems for advice.

For silicon diode sensor cryopumps, check that the read-out unit is correctly set for the diode type fitted to the pump (or check that the diode 'lookup' table being used is correct).

Helium gas contamination: this will freeze within the coldhead to impair performance. Likely only if gas has been added to the system (leaks) or an adsorber service change (15000 hours) has been missed. Performance is usually normal after regeneration but degrades with time. Carry out purge procedure (see Section 5.3.2). Replace adsorber if necessary (contact Oxford Cryosystems for advice).

Cryopanel surface contamination has reduced surface reflectivity increasing the radiant load to the pump. Clean the Cryopanels (see Section 5.4.2 and 5.4.3).

5.6.3 System base pressure abnormally high with cryopump operating below 20K

Vacuum leaks in system or cryopump. Shut down the cryopump and carry out a leak test.

The second-stage Cryopanel array has reached its capacity limit; system base pressure continues to rise with continued pumping. Regenerate the pump.

The second-stage Cryopanel has been contaminated (oil, vapour, hydrocarbons etc) seriously reducing its pumping capacity. Only likely if regeneration interval is significantly less than would be expected. Replace second-stage Cryopanel array.

The second-stage Cryopanel is loose. Only likely if the cryopump has been dismantled.

5.6.4 Abnormally high system pressure with cryopump operating above 20K

Large vacuum leak in system or cryopump, cryopump body very cold to the touch. Leak check the system and leak check cryopump pressure-relief valve.

The pumping capacity of the second-stage has been exceeded. Only likely if last regeneration was some weeks ago.

High radiant heat load from system to the cryopump, raising second-stage array to a temperature in excess of 20K, releasing previously pumped gas (hydrogen, helium etc). Close system valve and check for recovery. Fit baffle between cryopump and system.

Inefficient coldhead operation resulting from worn coldhead seals or valve. Only likely if cryopump has run for over 1 year. Service the coldhead (contact Oxford Cryosystems for advice and a coldhead service kit).

5.6.5 Cryopump will not cool below ambient temperature. Coldhead displacer motion (light tapping) cannot be heard

Gas supply and return lines incorrectly installed or coupled (see Section 3.4).

Coldhead power cable not connected.

Faulty coldhead valve motor. Check motor winding resistance at the coldhead connections. Resistance should be:

A-B 10 Ohms
C-D 10 Ohms

Check that the resistance between any pin and ground (coldhead metal work) is greater than 1 MOhm.

Faulty coldhead motor cable. Check continuity pin-to-pin on motor cable.

Compressor drive electronics faulty. Contact Oxford Cryosystems for advice.

5.6.6 Cryopump takes an excessively long time to cool to 20K

Low helium gas pressure. Check compressor run pressure is 21 ± 1 bar. Add gas if necessary (see Section 5.2).

Incorrect system configuration. Check correct palette setting for pump/compressor combination and set configuration at compressor accordingly (see Cryodrive Installation and Operation manual, contact Oxford Cryosystems for a copy of the manual if required).

Insufficient degree of pre-evacuation prior to starting the cryopump. Cryopump body will usually get very cold to the touch. Shut down pump and allow warming to ambient temperature. Repeat cryopump start-up procedure.

A leak in the cryopump has raised the cryopump pressure during cool down to a level preventing the cryopump from cooling efficiently. Cryopump body cold to touch. Leak check the cryopump (particularly the pressure relief-valve if this problem has not previously been experienced).

Coldhead internal seals are worn resulting in poor cooling power. Likely if last seal change was over 10,000 hours ago. Change seals.

5.6.7 Cryopump temperature unstable during operation

Coldhead seals require replacement. Likely only if last seal change was over 10,000 hours ago. Change coldhead seals.

For silicon diode sensor pumps, carbon debris from the second-stage Cryopanel array has migrated to the diode feed-through causing an intermittent short or earth leakage on the diode sensor leads. Invert cryopump if possible to dislodge material.

Alternatively, carefully remove the diode feed-through from the cryopump base flange (avoid stressing the fine diode wires) and blow out the debris. Check for correct operation prior to returning the cryopump to service.

RF interference on diode leads or diode cable. Screen the cable runs.

5.6.8 Intermittent operation of coldhead displacer

Serious gas contamination of the helium circuit. Carry out purge procedure (see Section 5.3.2).

High friction force of coldhead displacer seals after replacement. Seals will eventually 'bed in' to perform normally if the displace is moving. If the displacer is not moving or is moving very infrequently dismantle the coldhead and measure the seal frictional force. Contact Oxford Cryosystems for advice.

6 Storage and disposal

6.1 Storage

Note: If you store a new cryopump in conditions of high humidity, remove the cryopump from its cardboard packaging box; dispose of the box (refer to Section 6.2).

Use the following procedure to store the cryopump:

1. Shut-down the cryopump as described in Section 4.3.

2. Remove the cryopump from the vacuum system.

3. Fit the protective cover over the vacuum-shroud inlet-flange.

4. Store the cryopump in cool dry conditions until required for use. When required, prepare and install the cryopump as described in Section 3.

If the cryopump is to remain connected to the vacuum system during a long-term shut-down storage period, the high-vacuum pumping surfaces can be kept clean by maintaining the cryopump either under vacuum or at atmospheric pressure with dry nitrogen or argon. The remainder of the high-vacuum pumping installation, compressor, gas lines and coldhead, will be fully protected during long term storage if kept under positive helium pressure, with all components left connected. You must check the compressor unit pressure gauge regularly to ensure that a static pressure above 15.5 bar is being maintained.

6.2 Disposal

Dispose of the cryopump and any components removed from it safely in accordance with all local and national safety and environmental requirements.

You must take particular care with components which have been contaminated with dangerous process substances.

Do not incinerate fluoro-elastomer seals and 'O' rings.

7 Service, spares and accessories

7.1 Introduction

Products, spares and accessories are available from Oxford Cryosystems. When ordering spare parts and accessories, please state for each part required:

- Model and item number of your equipment
- Serial number of your system
- Item number and description of kit required

7.2 Service

For more information about service options, contact Oxford Cryosystems.

Note: Before you send us your system you must contact us by telephone or email and obtain a reference (RMA) number (see Section 8).

7.3 Spares

The following maintenance kits contain all of the parts you will need to maintain your pump. The maintenance kits also include instructions for the use of the kits.

Pump Type	**Kit Description**	**Item Number**
Coolstar 400 and 800	Cryopump Service Kit	B526-01-800
Coolstar 1500 and 3500	Cryopump Service Kit	8528-01-800
Coolstar 400 and 800	Coldhead service Kit	B519-01-800
Coolstar 1500 and 3500	Coldhead service Kit	B519-07-800
Coolstar 400	First stage panel set	B526-01-840
Coolstar 800	First stage panel set	B527-01-840
Coolstar 1500	First stage panel set	B528-01-840
Coolstar 3500	First stage panel set	B530-01-840
Coolstar 400	Second stage panel kit	B526-01-841
Coolstar 800	Second stage panel kit	B527-01-841
Coolstar 1500	Second stage panel kit	B528-01-841
Coolstar 3500	Second stage panel kit	B530-01-841
Coolstar 400 and 800	Spare hydrogen vapour bulb	B517-07-000
Coolstar I500 and 3500	Spare hydrogen vapour bulb	B517-08-000

7.4 Accessories

A range of accessories if available for the Coolstar cryopumps.

7.4.1 Helium pipelines: 'T' and 'X' pieces

A full range of helium gas-lines and 'T' and 'X' pieces to connect your cryopump to your system are available.

Product	Item number
Helium gas-line, 3m, pack of 2	
Coolstar 400 and 800	B517-17-000
Coolstar 1500 and 3500	B517-15-000
Extension helium gas-line, 3m, pack of 2	B517-16-000
Helium gas-line 'T' piece, pack of 2	B517-38-000
Helium gas-line 'X' piece, pack of 2	B517-39-000

7.4.2 Stepper motor power cable and cable splitters

To connect your cryopump stepper motor to your cryo-control system. Supplied in 10m lengths, you will need a splitter if you wish to connect two cryopumps to one cryo-control channel.

Product	Item number
Coolstar power cable, 3m	B219-05-014
Coolstar power cable, 10m	B215-05-016
Coolstar power cable line splitter	B219-05-017

7.4.3 TI10 temperature indicator

You can mount this indicator unit close to your pump to monitor the output from the silicon diode temperature sensor on the cryopump. The indicator has three indicator LEDs. The green LED indicates that the pump is in normal operation, the amber that regeneration is required and the red is lit when the pump is warming up (in the regeneration phase). If the LEDs flash, this indicates that the pump has overheated or that the silicon diode sensor is faulty.

Product	Item number
TI10 temperature indicator	
110V 1ph 50/60 Hz	D517-12-988
220V 1ph 50/60 Hz	D517-13-930

7.4.4 Silicon diode upgrade kit

Product	Item number
Silicon diode upgrade kit	B517-21-000

7.4.5 Silicon diode extension cable

Product	Item number
Silicon diode extension cable, 3m	B219-05-004

7.4.6 CHB heater band

Use the heater band to accelerate the regeneration cycle of the cryopump by up to 40%. The band is clamped around the outside of the cryopump to reduce the warm-up phase by as much as 60%.

Product	Item number
Heater band, 110/220V 1ph 50/60 Hz	
CHB400 heater band	H017-12-005
CHB800 heater band	H017-12-006
CHB1500 heater band	H017-12-007
CHB3500 heater band	H017-12-008

7.4.7 PA5 nitrogen purge valve

Use this accessory to connect a dry nitrogen purge supply to the purge port of the cryopumps. The nitrogen purge is used to dilute and flush gases accumulating in the pump during the warm-up phase of the regeneration cycle.

Product	Item number
PA5 nitrogen purge valve 1ph 50/60 Hz	
110V	B517-03-988
220V	B517-04-930

7.4.8 Cryodrive charge and vent adaptor

Use this accessory to vent helium from, and add helium to the Cryodrive helium circuit during maintenance. The adaptor is connected to the charge and vent port behind the front panel of the Cryodrive or to the helium gas-line connectors at the coldhead.

Product	Item number
Cryodrive charge and vent adaptor	B517-30-000

8 Equipment return procedure

8.1 Introduction

Before you return your equipment you must warn Oxford Cryosystems if the substances you used (and produced) in the equipment can be dangerous. You must do this to comply with health and safety at work laws. If you do not contact us before sending any equipment there will be a delay in processing your system.

8.1.1 Oxford Cryosystems Ltd contact details:

Email: support@oxfordcryosystems.co.uk

Phone: +44 (0)1993 883488

Fax: +44 (0)1993 883988

8.2 Guidelines

Take note of the following guidelines:

Your equipment is 'uncontaminated' if it has not been used or if it has only been used with substances that are not dangerous. Your equipment is 'contaminated' if it has been used with any dangerous substances.

If your equipment has been used with radioactive substances, you must decontaminate it before you return it to us. If you require more information please phone or email for advice.

We recommend that contaminated equipment be transported in vehicles where the driver does not share the same air space as the equipment.

8.3 Returns procedure

Use the following procedure:

1. Contact Oxford Cryosystems Ltd and obtain an 'RMA' number for your equipment.

2. Remove all traces of dangerous gases: pass an inert gas through the equipment and any accessories that will be returned to Oxford Cryosystems. Drain all fluids and lubricants from the equipment and its accessories.

3. Disconnect all accessories from the equipment.

4. Seal up all of the equipment's inlets and outlets (including those where accessories were attached). You may seal the inlets and outlets with blanking flanges or heavy gauge PVC tape.

5. Seal contaminated equipment in a thick polythene bag. If you do not have a polythene bag large enough to contain the equipment, you can use a thick polythene sheet.

6. If the equipment is large, strap the equipment and its accessories to a wooden pallet. Preferably, the pallet should be no larger than 510mm x 915mm (20"x 35"); contact Oxford Cryosystems if you cannot meet this requirement.

7. If the equipment is too small to be strapped to a pallet, pack it in a suitable strong box.

8. If the equipment is contaminated, label the pallet (or box) in accordance with laws covering the transport of dangerous substances.

WRITE YOUR 'RMA' NUMBER CLEARLY ON THE OUTSIDE OF THE EQUIPMENT PACKAGE.